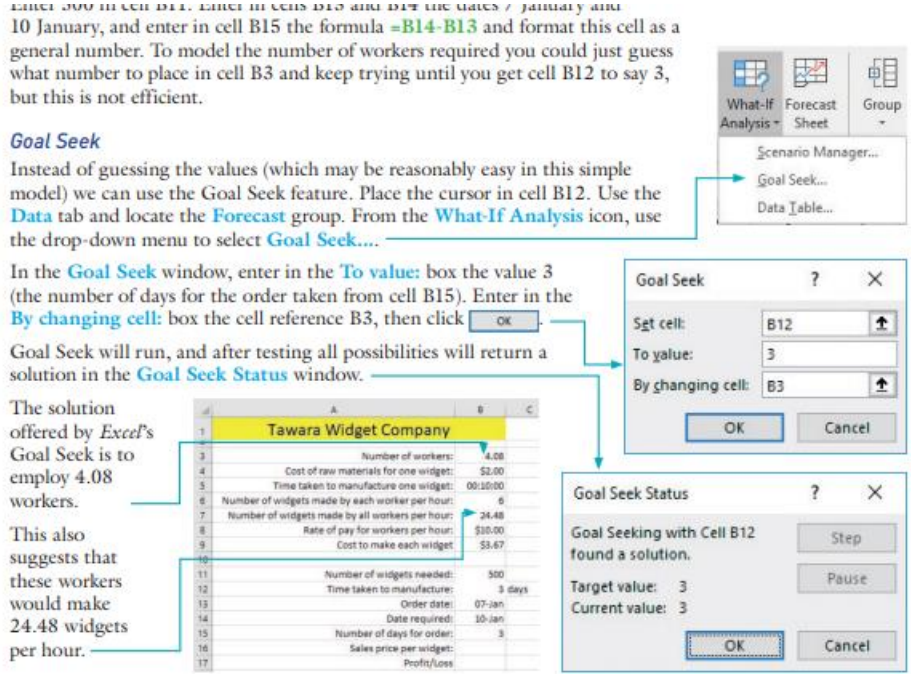
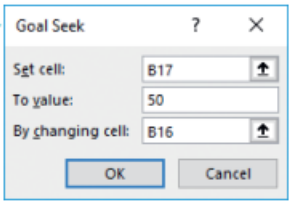
9 Modelling

9.1 What-if analysis

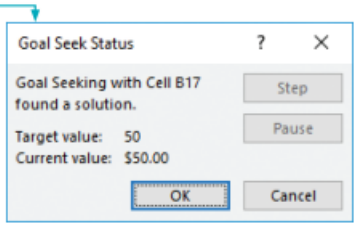
- Computer models all base their model upon a what-if analysis which involves changing a mode to find out what the results would be, if different input values are changing.
- It is basically asking a question such as *what* will happen *if* I perform a certain action
- Goal Seek feature is a what-if analysis tool that enables you to find the input values needed to achieve a goal or objective making what-if analysis more precise
- To use Goal Seek, you select the cell containing the formula that will return the result you are seeking.
- You then input the value you want the formula to return and enter the cell reference of the input value that the spreadsheet can change to reach the target


10 January, and enter in cell B15 the formula =B14-B13 and format this cell as a general number. To model the number of workers required you could just guess what number to place in cell B3 and keep trying until you get cell B12 to say 3, but this is not efficient.
Goal Seek
Instead of guessing the values (which may be reasonably easy in this simple model) we can use the Goal Seek feature. Place the cursor in cell B12. Use the Data tab and locate the Forecast group. From the What-If Analysis icon, use the drop-down menu to select Goal Seek....
What-If Analysis
Forecast Sheet
Group
Scenario Manager...
Goal Seek...
Data Table...
In the Goal Seek window, enter in the To value: box the value 3 (the number of days for the order taken from cell B15). Enter in the By changing cell: box the cell reference B3, then click OK.
Goal Seek will run, and after testing all possibilities will return a solution in the Goal Seek Status window.
Goal Seek
Set cell: B12
To value: 3
By changing cell: B3
OK
Cancel
The solution offered by Excel's Goal Seek is to employ 4.08 workers.
This also suggests that these workers would make 24.48 widgets per hour.
Tawara Widget Company
Number of workers: 4.08
Cost of raw materials for one widget: $2.00
Time taken to manufacture one widget: 00:10:00
Number of widgets made by each worker per hour: 6
Number of widgets made by all workers per hour: 24.48
Rate of pay for workers per hour: $10.00
Cost to make each widget $3.67
Number of widgets needed: 500
Time taken to manufacture: 3 days
Order date: 07-Jan
Date required: 10-Jan
Number of days for order: 3
Sales price per widget:
Profit/Loss
Goal Seek Status
Goal Seeking with Cell B12 found a solution.
Target value: 3
Current value: 3
Step
Pause
OK
Cancel
q4w22/p12

To produce a realistic working solution, the number of workers will need changing to 5 which will change the contents of cell B7 to 30. To calculate the sales price required per widget to make a $50 profit, place the cursor into cell B17, then from the Data tab select the What-If Analysis icon, then Goal Seek.... Edit the Goal Seek window to look like this.



Click OK to run the Goal Seek. Goal Seek will run, and after testing all possibilities will return a solution in the Goal Seek Status window.



This returns in cell B16 a value of 3.76666666666667, which needs to be rounded up to $3.77 (it may appear to hold this already if you have formatted the cell to two decimal places). Change the value in cell B16 to $3.77 which will return a profit of $51.67.

Advice

Remember, formatting to a number of decimal places does not change the original value.

9.2 The characteristics of modelling software

- **Replication** means you don't have to enter the same formula or data several time
- **Absolute and relative referencing** makes sure you only increment parts of a formula you when to when replicating a formula
- Allows **what-if questions** to be asked
- The use of **cell protection**, it ensures that the cells which are crucial to your model are not changed accidentally by someone using the software
- **User interface forms** allows easy entry of values into model by showing clearly where the data needs to be entered
- **Macros**, it allows keystrokes you make on your keyboard to be stored which makes it easier to create more complex formulae or function
- **Goal seek** can be used to determine which variable need to be changed to achieve a target or goal
- **Pre-written functions** allow user to create complex formulae
- **Automatic recalculation**, allows data to be automatically recalculated when altered
- **Conditional formatting**, allows you to instantly highlight certain values that match specific criteria.
- **Use of graphs or charts**¸ makes it easier to show trends/predictions over a given period of time.

9.3 The need for computer models

Cost

- We need models because of costs

- If engineers are designing structure such as bridges and high-rise buildings or designing cars and planes it is very expensive to correct mistakes
- If a computer model is used, then the costs of any mistakes practically disappear.

Testing

- For the ability to test the design
- It would be impossible to build several types of buildings just to see which is most likely to survive a crash
- However, it can be done relatively easy with a computer model

Prediction

- It is impossible to travel through time, so in order to predict events over a large time span, such as climate change r population growth, computer modes are used as they are the best way of making predictions
- Another use of computer models is to accurately predict when storms will occur and the severity of them, thus enabling early warning to the public about how to protect themselves and their property

Time-Efficiency

- Modelling saves time as well as money.
- Car manufacturers can perform more tests in a shorter space of time with a computer model than by arranging tests of prototypes with crash-test dummies inside them over and over again.
- Computer models make it possible to run many more tests.

Planning

- Simulations are a specific type of computer model and are very useful in planning for rare or unexpected events
- For example, they can be used to help predict and plan for the after-effects for natural disasters, such as volcanic eruptions, earthquakes and tsunamis

Safety

- Some situations are dangerous, such as experimenting with a nuclear reactor.
- A computer model is a much safer way to do this.

9.4 The effectiveness of spreadsheet models

Benefits

- Spreadsheet models can do complex calculations
- Calculation can be performed much quicker than if you were writing them or using a calculator as the formulae are recalculated automatically.
- Data can be automatically imported into a spreadsheet from a database, saves the trouble of having to manually input data
- Spreadsheet models are very useful for observing patterns which take place over a long period of time, especially for studying animal population growth
- Automatic updating of graphs
- They can remove human fallibility; the likelihood of decisions being made based on personal feelings is no longer a problem.
- Decisions made by spreadsheets are consistent for the same inputs making it reliable.
- Templates exist for regularly used spreadsheets which saves time as fewer amendments need to be made for the particular situation. Users don't need to have great computing expertise.
- Validation rules can be built into spreadsheet models which reducing data input errors.
- Graphs that are produced to show (population growth for eg) will automatically change as old values are altered

Drawbacks

- It is very difficult to include every possible variable in a spreadsheet model which could give misleading results
- To try to account for as many variables as possible requires complex formulae which may need experts who are expensive to hire
- Producing an effective model may be time consuming
- The model can have formula replicated
- Complex (exp population) predictions may need additional software/modules which is expensive to buy
- Staff that is going to use the spreadsheet model needs to be trained which creates another expense on top of creating the model.

9.5 Uses of computer models

Financial Forecasting

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Population Growth

Climate Change

Weather Systems

Queue Management

Traffic Flow

Construction

9.6 Simulations

- A computer simulation is when a computer is used to imitate an event as it happens in real world
- A simulation is created usually from a mathematical model which represents the real system
- It consists of computer programs which are written to include the main features of this real-world system
- The model is the representation of the system, whereas the simulation is how the system performs over time

Advantages of Simulation

- Don’t have to worry about the cost of repairing and replacing damaged cars or airplanes
- You may need fewer driving or flying instructors resulting in lower costs
- Simulators can provide results that are generally difficult to measure such as reaction times
- With a simulator you can see how a system might work before you design or modify it, resulting in fewer mistakes in the system
- A simulator prevents safety problems such as injury or even death in the event of a car or plane crash
- Some events such as extreme weather conditions can be recreated fairly easily without having to wait for them to happen in real life
- Can obtain results in a short period of time regarding reactions that take a long time in real life

Disadvantages of Simulation

- Buying a simulator with a fast processor and large amount of memory can be very expensive
- The technical support for such systems can prove to be more expensive than regular servicing of airplanes and vehicles
- A driving school using a simulator from scratch will need to retrain driving instructors, costing money and taking time
- The unpredictability of human behavior means it may be impossible to create simulations that cover all possibilities
- Inaccurate output from the simulation can still occur as the formulae and functions may not accurately represent all possible scenarios
- It may make the drivers or pilots overconfident and too casual regarding their abilities
- There is sometimes not sufficient data to produce a mathematical model
- Specialist knowledge is required to analyze results which requires specialists which costs money
- Simulations may not be 100% accurate

Natural Disaster Planning

Pilot Training

- Training multiple new pilots and training existing pilots to fly new aircrafts can be done cheaply and safely using a simulator

- A simulator is designed to react to a pilot's instructions just like an actual aircraft would
- A flight simulator used by airlines is a purpose-built cabin
- The cabin contains an aircraft cockpit just like the real thing as it includes flight controls and instrumentation, an adjustable pilot seal and a system and computer hardware

Learning To Drive A Car

Nuclear Science Research